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INTERNATIONAL HEALTH EXHIBITION

LECTURES.

FOUL AIR IN HOUSES.

*A Lecture delivered in the Lecture Room of the
Exhibition, July 4th, 1884.*

BY PROFESSOR CORFIELD.

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FRIDAY, JULY 4TH, 1884.

LECTURE ON "FOUL AIR IN HOUSES."

By PROFESSOR CORFIELD.

Dr. HERON in the Chair.

THE CHAIRMAN: Ladies and Gentlemen, in the absence of Sir Philip Cunliffe-Owen, I have been asked to take the Chair on this occasion, and as you have come here to listen to Dr. Corfield, and not to me, I will not detain you a moment, but simply introduce to you Professor Corfield, who will deliver a lecture to you on "Foul Air."

PROFESSOR CORFIELD: Mr. Chairman, Ladies, and Gentlemen, after thinking for some time about the subject I should take for this lecture, I have thought it better to take some subject which would be practically interesting to a large number of people, and I have selected one in which everybody ought to take an interest, although in some degree, perhaps, not a very savoury subject.

In the first place let us consider the impurities which get into the air in houses from the respiration of the human beings in them. The air that is breathed out is, as we all know, not of the same composition as the air that is breathed in; it has lost some of its oxygen, and it has gained carbonic acid, which is poisonous, and also a certain amount of organic matter and moisture. This air is irrespirable, you cannot breathe it again; that is to say, that air which

contains a diminished quantity of oxygen, and an increased quantity of carbonic acid, together with the other matters I have mentioned, is irrespirable. But that of course is not the air that we generally find in buildings, or we could not live in them. Let me bring before you the results of breathing air that has been breathed before, but mixed more or less with fresh air. I will take, as an instance, one of the worst examples on record, the Black Hole of Calcutta. In the Black Hole of Calcutta, on June 20th, 1756, there were placed 146 persons. The Black Hole was a little place, measuring about eighteen feet each way, with two windows strongly barred. These persons remained there during the night for about ten hours. That space would be equivalent to rather less than forty cubic feet of air for each person. Some who were near the windows got a certain amount of air, and after the first hour or two, small quantities of water were given them; and so they remained during the night. The result was that of the 146 persons who were put into that place, 123 were found dead in the morning, and the 23 survivors broke out in boils all over, and had what has been described as a high putrid fever. That shows you the result of breathing air which is highly contaminated with the products of respiration. Air which has become highly contaminated in this way affords a nidus in which the poison germs of typhus fever grow. That is a fever which is specially characteristic of overcrowded places. It is the fever which used to be called "Gaol fever," from which in former times so many prisoners used to suffer; a disease which they used occasionally to bring into court with them from the prisons, giving it by contact with their clothes to the gaolers and jurors, and even the judges themselves used to be attacked with it: so that the courts had to be closed. That is a fever which affects places in which the atmosphere contains a very large proportion of the products of respiration, and it is a fever, which not only is characteristic of those places, but is being abolished, as we abolish overcrowded places: wherever we are getting rid of the overcrowded dens in which people live, typhus

fever is being abolished altogether, and very soon it will be a thing of the past. Typhus fever when it is taken from a crowded place to a place which is not crowded, although a highly contagious fever, does not spread. I have never known an instance where it has been brought into a house where there was no overcrowding, of another case being found there. So that it is evidently a disease which is not only characteristic of overcrowded places, but it will not flourish anywhere else. But when the air is in this condition, there is another disease which is very prevalent, and that is consumption. That disease, in this connection, has been noticed by many medical authorities; but more notably by Dr. Guy. Dr. Guy mentions the case of a printing establishment, in which the workers had only just over 200 cubic feet each, and they died in it from consumption, just as if it was some contagious fever. Those are the diseases which prevail in houses where the air is breathed over and over again.

Now, let us see what is the reason why those diseases prevail in such air, and what is the reason why air which has been breathed is unfit to be breathed again. What is the reason why the air of rooms containing a considerable proportion of air that has been breathed is unwholesome? Because it is quite clear that it is unwholesome. Well, in the first place, is it the diminution in the quantity of oxygen in such air? As a matter of fact, taking the oxygen in the outer air at 2096 parts in 10,000 parts of air, the oxygen in the air of exceedingly bad ventilated atmospheres is only reduced to 2080 or 2075. You may find in very rare instances, in excessively badly ventilated rooms, that the oxygen is reduced to 2070. So that really the diminution of oxygen is exceedingly slight, and it is a diminution which can in no way account for the results of breathing such atmospheres. The diminution of oxygen then is not competent to account for the results. Then, in the next place, is the increase in the quantity of carbonic acid, of which so much has been heard, sufficient to account for the results of breathing such atmospheres?

On the contrary, the increase of carbonic acid, which is found even in the worst ventilated atmospheres, is so small, that it is in fact a matter of no importance. Carbonic acid, although a poisonous gas, is not by any means so poisonous as is commonly supposed. Air containing even two per cent. of it is not injurious to anything like the extent that I have mentioned as the results of breathing badly ventilated atmospheres; and when we consider that even the worst ventilated atmospheres only contain about one part of carbonic acid in 1000 parts of air, whereas even two per cent. would be a matter of no consequence, or very little consequence, as far as we can say at present, you will see that the increase of carbonic acid has very little to do in spreading typhus fever and consumption. What is it then that is so deleterious in improperly ventilated places, and which produces these evil results? It is unquestionably the presence of the foul putrescible organic matters in air which has been breathed. Those foul organic matters are a matter of much more importance than the increase of carbonic acid. That was shown to people long ago by an Italian experimenter called Polli. He placed animals under conditions where they would breathe different atmospheres; some he put in an atmosphere in which lime was placed to absorb the carbonic acid and moisture; some in an atmosphere in which charcoal was placed to absorb organic impurities; and some in an atmosphere in which no precaution was taken at all. And it was found that the animals placed in an atmosphere where no precaution had been taken died first; those put in an atmosphere containing lime, which absorbs carbonic acid and moisture, died next; and those in the atmosphere containing charcoal, which oxidises organic matters, died last. So that, by his experiments, Polli long ago showed people the results, at which we have only arrived quite recently, in regard to the contamination of the air by organic matter. I want you to be quite clear in your minds that the increase of carbonic acid is nothing more than of the slightest importance in the question of the deterioration of the atmosphere. At the same time it is quite

true that the amount of increase of carbonic acid in the atmosphere is a very good test of its condition and purity. We are enabled to test that very accurately, in proportion to the amount of carbonic acid present in it ; so that it is an exceedingly useful test for us, and it is by its presence that we are able to test the qualities of our atmospheres. Now the atmospheres in inhabited places have been divided by Professor de Chaumont into classes, according to the sensations which are experienced on entering them from the outer air. The first class of atmospheres are those which appear fresh when you come into them from the outer air, and have no close smell. Those are the atmospheres of the properly ventilated places, places in which the organic matter has been constantly got rid of, and has not got to such a point that you can distinguish it. Those are places where, if the carbonic acid in the outer air is taken to be four parts in 10,000, there will not be in the atmospheres more than six parts, or an increase of two parts of carbonic acid. The next class of atmospheres are those in which there is a little closeness observed on entering. Those are atmospheres of the second class, and in them the organic matter in the air, and the excess of moisture, have got to such a pitch that you can detect them on entering the room from the outer air ; and I want here to show you how extremely small the increase in the carbonic acid is : because if the carbonic acid in the outer air is four, the proportion in these atmospheres will not be more than eight, that is to say, not more than four parts more. In the third class we find the atmospheres of places in which, when you come into them from the outer air you find the sensation is disagreeable, that is to say, that the organic matter has increased until there is a disagreeable sensation experienced, and the quantity of carbonic acid is again increased. In the next class of atmospheres the sensations become very oppressive ; and taking the increase of the carbonic acid as the key to the condition of the atmospheres, it is found that the amount of carbonic acid increases progressively with the

disagreeable character of the sensations which are produced. So that the sensations which are produced upon a person entering a room from the outside, are an accurate guide. Those sensations which are produced upon a person entering a room from the outside atmosphere, tested by the presence of the carbonic acid, are found to be quite accurate ; those sensations give you an accurate idea of the amount of the organic impurity in the air, and that impurity has been tested in the way I have mentioned to you, by means of the amount of carbonic acid present.

From the considerations which follow from this, and from the fact that in atmospheres which are properly ventilated the amount of carbonic acid does not exceed that in the outer air by more than two parts in 10,000, we are able to find the amount of air required by each individual every hour. That quantity is 3000 cubic feet in an hour, and that supply of air is required to keep rooms fresh ; and if we require that quantity to keep them fresh, it is hardly necessary to point out that, as no rooms are made large enough to give that quantity, the air in our rooms must be changed. Take a room in which a person sits for several hours, or a bedroom where a person sleeps for seven hours ; he requires 21,000 cubic feet of air to breathe, so that he would require a room to be of dimensions such as really no ordinary sleeping room has, nor anything like them. It is quite clear, therefore, that a change of air is necessary ; and, in order to keep the atmosphere in houses in a sufficient state of purity for the people to breathe it, we are justified in laying down the law, that if an atmosphere is in such a condition, that a disagreeable sensation is perceived upon going into it, that atmosphere is not properly ventilated, and is not fit to live in.

Now, I am not going to take up your time by describing to you the various methods of ventilation in this lecture, because that belongs to another subject ; this lecture being on foul air, and the results from it. I will now, therefore, pass on to consider another kind of foul air, and that is the foul air in houses, which is not produced by breathing.

First, we will take the foul air arising from sewers and drains. In sewers and drains there is always foul air arising from putrescible matters, which get into places where they are not flushed away, and which decompose, producing foul air. The results manifested from the entrance of such air into houses, whatever way it gets in, are to be seen in the appearance of certain diseases. Those diseases are in the first place sore throats and fevers. Sore throats are exceedingly common in houses where there is foul air. Diphtheria is very common in such houses, and scarlet fever is not at all uncommon in them. Diarrhœa and typhoid fever are common for another reason in those houses, too ; and besides that, there is a general malaise, a general state of ill-health. A general state of being out of condition is found among people who live in houses into which the foul air from the drains gets. We have now to consider how such foul air gets into houses, or some of the ways at any rate, in which such foul air gets into houses. It gets in through bad appliances ; through defective work, or even defective arrangements of good appliances ; through over use of things, by which they get worn out (and are not replaced), or by which they get out of order ; and still more by the disuse of such things. Now, in the first place the drains themselves are very often made of porous bricks, which allow the foul air to come out of them, and sometimes the foul water too. If the foul water escapes out of them, it is practically the same thing as if foul air escaped out of them ; because it soaks into the soil around and produces bad air, which passes into the houses sometimes in very considerable quantities, so that whether you have an escape of foul air, or foul liquid from the drains, it comes to very much the same thing. Drains are very often made of porous materials, and frequently of bricks and mortar, which are very improper materials for them to be made of. They were formerly very properly made of bricks and mortar ; because they were intended for drainage purposes, that is to say, they were intended to drain the water from the soil, and they were, therefore, intended to be made for

the water to get into them ; but when they are to be used as sewers, they ought to be made of impervious materials, so that the foul water which passes into them cannot get out of them. However, they are frequently made of porous materials, or badly jointed ; and besides that, rats disturb drains which are made in such a way, they burrow underneath the pipes and let them down, and then they make runs under the floors in such houses, and go in fact wherever they can follow the drains. The presence of rats in a house, therefore, is always to be regarded as a sign that the drains are out of order. Then they are also a source of danger ; because wherever rats go the foul air from the drains can follow them, and also rats take a certain amount of filth with them from the drains, and as they generally find their way into the larder, they take that filth, therefore, to any food they come across. Sometimes, also, they get into the water cistern, and pollute the water supply in the same way. So that you see the presence of rats in a house is a sign that the drains are in bad condition, and that there is a means of foul air coming from them into the house. Rats do not always confine themselves to a particular house under which the drains may be defective, but they get into neighbouring houses ; and I will give you a curious instance of that which came under my knowledge. The drain in that case was a pipe drain, and the lengths of pipe had been insufficiently joined together ; the rats burrowing under the pipes, let one of them fall out of joint, where they had been loosely put together. Then the rats, by means of the drain which they had so disturbed, got into the house. The next thing was that a nuisance was observed in the house, and what did the people do ? Instead of taking up the drains and putting in new ones, they patched them up, and then put down a layer, about six inches deep of concrete, all over the basement of the house, from one end to the other. That of course, as far as it went, was a very good thing to do. It is always an excellent thing to have an impervious layer of concrete in the basement ; because

it prevents air rising from the ground into the house. I may as well say here, though it hardly forms part of this particular subject, that if you do not have an impervious layer in the basement, houses will be affected by exhalations from the earth; because when fires and lights are burning at night, air is drawn into the house from the ground. That air is not fit to breathe even in the country, and it is much less fit to be breathed in towns. Well, to go on with the instance of the rats finding their way into adjoining houses. It was found that those rats came up through the hole in the drain all the same, the concrete of course did not prevent them going through the pipes; they found a place where they could get under the party-wall, and so they got into the kitchen of the next house. There they burrowed underneath the hearthstone, and made their nests. They came up, you see, out of the drain in the street, where there was no trap to prevent them, got out under the footings of the party-wall, and so into the kitchen of the next house, where they had a very nice time of it. In fact, they ran all over the next house, where the sanitary arrangements had been put into excellent condition. They lived and died there, until something had to be done to get rid of them; the hearthstone was taken up, and then it was found that there were no less than thirty-six dead rats in all stages of decay, in that which had been their living place, and also their dying place. That is a very curious instance of the way in which, if one person does not pay sufficient attention to the sanitary arrangements of his house, he may be the cause of creating a nuisance to other persons, even if he is not a nuisance to himself.

Then again foul air frequently gets into houses quite apart from the operations of rats, from pipe drains being improperly laid. They are frequently laid simply with the joints placed together, or what is called "dry," that is, without any cementing material being used at the joints. Of course when they are laid dry in that way the water runs out of them continually; there is no reason why it

should not, and foul air, too, comes out of them into the houses. That becomes still worse where there is no trap on the drain, which does not of course always happen. Sometimes, however, the pipes are not laid dry, but they are jointed with clay. Now, clay is a very bad jointing material; because it is apt to dry and crack, and it squeezes out with very little pressure on the pipes from the earth over them. If rats happen to get underneath them, in consequence of their burrowing combined with any pressure from the earth above, the pipes get shifted and leakages occur. Again, not infrequently pipes are laid with the joints the wrong way; instead of being laid with what is called the socket end up, they are laid with socket end downwards: and if the joints are made with clay, the clay cracks and squeezes out, the water runs out through the joints, and so the solid matters are left in the drain, which gradually gets blocked up. Even if pipes are jointed with cement, which is one good way of joining them, they may still leak, so that air comes out of them; or, they may be jointed with cement in such a way, that it is done imperfectly: the cement is only put in round the top of the joint, nothing being put underneath. That is not at all an uncommon way with builders of laying pipes, either for the sake of saving a little cost and trouble by scamping the work, or from mere carelessness. Of course the result of that is that, to all appearances, there is a nice well-laid drain; but it is not at all efficient for its purpose, and the consequence is that the foul water, or a great deal of it, finds its way out into the soil under the drain.

Now, it is very difficult to discover these defects, and they can only be found out by plugging the pipes, filling them with water, and seeing whether the water remains standing at the same level in them. If you plug a drain with clay tightly at the lower end, and fill it with water, until you find the water standing in it at the upper end, and then measure the depth of it; if you find it does not remain there, it is clearly leaking somewhere, and you must

find out where it is, or else the whole drain must be taken up and relaid.

Now, I think that will have to be enough in connection with drains, although there are some other points in reference to them which one might mention. I need hardly say, that similar remarks would apply in many cases where cesspools are found underneath houses.

The next things I shall mention to you are dustbins, which are a very fruitful source of disease in houses. They are frequently built against the wall of a house, or the space between the walls of adjoining houses is the place selected for the dustbin, where every kind of refuse is thrown. Foul air is generated in those dustbins from the foul decomposing organic matters, which ought never to be put in them. That foul air passes into the rooms in the basement, and from the basement into the rooms above. I have known very serious results follow from the passage of foul air from dustbins through the walls, right up into the dining or drawing rooms above, arising simply from the fact of the dustbins being placed close against the bricks ; because bricks of course are very porous. Another means by which the foul air from that source does mischief, is the existence sometimes of a loose joint in the rain-water pipe—sometimes the joints are not very tight—and the foul air from the dustbin passes up the rain-water pipe, and escapes, perhaps, into the balconies or drawing-room windows. Dustbins ought to be detached from the houses ; and they ought to be made of some impervious material, such as galvanised iron for instance, and the large wooden or brick dustbins, of the kind now so generally in use, ought no longer to be tolerated.

Then the next point I will refer to, is that very often connections are made with the drains directly from the floors in the basements of houses. This is very commonly the case in the scullery, and in lavatories and passages. Openings are made leading into the drains ; and the object of those openings being made is that when the passage or scullery, or wherever the opening is made, is swilled down, the water may

run down into the drains. This is a thing which should never be allowed, although of course those openings are trapped, with the object of preventing foul air going into the house. But the kind of trap which is most generally used for the purpose, is what is known as the bell-trap, from the shape of the cover of it. Here is a specimen of that kind of trap [producing same], and you would see that not only in almost every area in London, but you would see it in the floors of passages in houses, and in sinks. That, I think, is about the worst form of trap that has ever been devised, for a great many reasons. In the first place it holds a lot of filth, and that generates foul air ; the next thing is that it holds very little water, and even that diminishes as it gets full of filth, and as the trap is made only by the bell dipping to the depth of half an inch in the water, when that is evaporated the foul air comes straight into the house : because the trap is gone. Another thing is that when the bell is taken off, as it often is, the trap is of no use. The top has frequently to be taken off, because of these small holes in it getting filled up ; and when the place has to be swilled down, it has to be taken up to let the water escape, and it is not so frequently put on again. Once taken off, it may be left off for days, weeks, or months ; and I have known numbers of cases of disease and death to occur from that cause. Then again it often gets broken by some accident, the master or mistress is not told of it, and the place remains untrapped, perhaps for years. That is a form of trap which should not be tolerated inside a house, and the only good of it outside, is that it helps to ventilate drains, which otherwise would not be ventilated at all. But neither should a good trap be put in the floor of a house, and connected directly with the drain ; it should discharge into an inlet in a trapped gully outside.

It will be most convenient for us next to consider the soil pipes. Soil pipes are the pipes into which water-closets discharge, and they are very frequently placed in improper positions inside a house, and are also made of improper materials. Whatever materials they are made of, they

ought to be placed outside the house ; because if there is any defect in them, it is better that it should be outside the house than inside it. One of the commonest and best materials for them to be made of, if they are properly ventilated, is lead ; but it is not the best if they are not properly ventilated, because foul air has the property of eating holes through solid lead ; and I have got here several extraordinary instances of that to show you. Here is an example [producing a piece of pipe], where holes have been eaten through the solid lead by the action of the foul air. Where that is the case the foul air escapes, and causes epidemics of sore throats in the house, and other diseases are also produced by it. Here is another instance of the same thing [producing another specimen]. This is also a piece of a soil pipe ; they are so large here, that you can all, I have no doubt, see the holes which the foul air has produced in the pipe. That was taken out of a house not six weeks ago, in which an outbreak of disease of some kind or other, caused by the defective condition of that pipe, had occurred. This is a still more interesting piece, because it is an instance of a soil pipe, which is ventilated certainly, but in the wrong place. That fact, you see, has not prevented the collection of foul air, and the consequent formation of holes in the upper part of the pipe, and that shows the necessity of having the ventilating pipe at the top. Soil pipes may either be made defective in that way by foul air, or they may be made originally defective with the pipes merely slipped into one another at the joints without anything at all, or with only a little putty, and no proper cementing or soldering. The best soil pipes are made of lead, and if they are properly made and ventilated in the first instance, they will last for years. Iron, also, is frequently used for this purpose ; but I do not think, where the pipes are inside the house, it is an advisable material to use, because one can never feel quite sure of the joints. You have to join pieces of lead with it from the closets, and one never feels quite sure of a joint between iron and lead. So that I do not think it is a

good thing to have iron soil pipes inside houses, in this country at all events. I say in this country, because our American cousins insist upon the necessity of having iron soil pipes, and on the necessity of having them inside the house. Now soil pipes, as I have said, are frequently un-ventilated, or they are ventilated improperly with pipes that are too small, and very often put in the wrong place. The ventilating pipes are carried close to the tops of chimneys, and the foul air from them may be carried down the chimneys into the house. Then they are sometimes made to end too near the upper windows. I have seen them made to end not very far from the nursery windows ; and I have known diseases produced among children in that way. Occasionally, no doubt unintentionally, they are actually made to end practically inside the house. I have seen such instances, and those were instances where rain water has been brought into them by gutters, and in that way you occasionally find an open head positively inside the house. I found recently a case in the house, too, of a medical man, where there was always illness in the house ; where the open head of the soil pipe, into which the gutters joined, was in a cupboard on the top floor of the house. I had better here, I think, give you one more instance to show you how difficult it is sometimes to find out these things. In a large country house they occasionally found faint smells in some of the rooms. In one of those rooms, called the music room, the floor was taken up, and they went on until they came down to an old drain. They cleared that away, and filled in the ground ; but it was just the same as before, it made no difference, so that the smells evidently had nothing to do with that drain whatever. One way of testing how foul air escapes into a house, is by pouring some very strong smelling stuff down the pipes, and then seeing whether it can be smelt in the house. The thing most generally used for that purpose is oil of peppermint ; but oil of thyme, and also ether, are sometimes used. When that was done in this case not the slightest smell could be found in any part of the

house which was near to the soil-pipe which was tested, and we began to think it was all right ; but as the soil-pipe was unfortunately inside the house, it was examined thoroughly along the whole distance for which it could be seen. There was not the slightest escape of ether from it, and no defect whatever could be found in it. It had never occurred to anybody that any escape from the soil-pipe could reach the music room ; but when they went there they found that that room was full of ether, which was what was used in that case. The piece of soil-pipe inside the wall was then exposed, and it was found there was a hole in the pipe inside the wall, where the bricklayer had "made good," as it is called ; he had driven his chisel into it, but as he was not a plumber he could not mend it, and he just left it alone. The air from that hole got out underneath the passage, wandered under the floors, and appeared at last in this room, which was on the other side of the passage. That is a very curious instance of the way in which foul air will travel about houses in extraordinary ways. Sometimes soil-pipes are improperly connected with the drain at the bottom, and sometimes they are not connected with it at all ; they sometimes simply open into the ground through the floor, and there is a space left for the water to run into a hole left in the drain. I have known that to happen more than once, and it occurred once in my own house ; but I need hardly say, it did not remain in that condition long. In such cases the foul matters of course escape and percolate into the soil around, and so foul air gets into the house. There is another thing which I want to mention to you in connection with soil-pipes, which often occurs where they are connected directly with the drain. In a house where the children in the schoolroom were continually suffering with something or other, the drainage arrangements had been, it was supposed, all put right ; but it was found that the pipe from a closet passed down under the schoolroom floor, and there was a pipe in the basement leading down into the drain. On taking up the floor, it

was found that the discharge was really made into a space between two arches, so that it formed a sort of cesspool; and in that way actually underneath this school-room, where the children had been sitting over their lessons for hours every day, there was simply an open cesspool, connected with the drain.

Foul smells, also, get into houses from bad forms of closet arrangements. I have not time to go into this subject at any length; but I will merely mention to you, that the "pan-closet," which is perhaps more used than any other, is one of the worst forms of sanitary arrangements that has ever been devised. This, which is called the "D" trap, from being like the letter D [showing specimen], is the trap very commonly used in connection with the pan-closet; you may have everything else as right as you like, but if you have a pan-closet in a house, it is certain to be a nuisance, especially if there is a D trap connected with it. This trap, as you can see from its shape, is nothing more or less than a small leaden cesspool, and the water that passes through it cannot possibly clean out the contents from every part of it, and consequently they decompose there and give out foul air, which escapes into the house. Let me here show you one or two other things in connection with this matter. This [showing specimen] is an instance in which foul air has eaten holes in the top of the trap, and it is another instance of an improper sanitary arrangement, which is very common, namely, the connection of waste pipes with the traps of water-closets. One of these came from the housemaid's sink, and there is one, it is not at all unlikely, which came from the cistern. Of course those pipes, which are so connected with the trap of the closet, afford a means for the foul air to escape into the sinks or cisterns, or baths, or wherever those waste pipes come from. Before I leave this subject of the pan-closet, I must mention one thing in connection with it, which makes it so exceedingly objectionable in itself, and that is, that underneath the seat there is a large iron box, called the container, in which the pan, as it is called, is

placed, so that it can be moved. This large iron box is above the "D" trap, and so is always full of foul air, which escapes continually into the house by passing through the small quantity of water in the receptacle called the pan. There is a still worse arrangement in these closets. The container not unfrequently has a small hole bored in it at the top, and when the apparatus is worked foul air is forced out from the container into the closet room, with sufficient force to blow out a candle. That is frequently a very common source of disease, and I have known many cases of houses, with such arrangements, where epidemics of sore throats and other kinds of illness were prevalent. This form of closet arrangement should be abolished, and it really ought not to be tolerated any more. I have mentioned to you the mistake of connecting waste-pipes with the traps of water-closets; waste-pipes from sinks ought not to be connected at all with a drain directly even when trapped; they ought to be made to discharge into the open air, and even then I say, that if they are not trapped under the sinks, you will still have foul air coming into the house. The air that comes in is not from the drain, but you must remember the pipe is a dirty pipe, soap and grease of all kinds go down it, and it is not a proper pipe, therefore, for a ventilator. There ought to be a siphon trap on it, which would hold a little water, so as to prevent any air coming through the waste-pipe into the house at all. Then if the waste-pipes of sinks should not be connected with drains, they should certainly not be connected with soil-pipes, as they frequently are. A very common source of illness is the connection of the housemaid's sink with the soil-pipe. You find not at all unfrequently a very nasty, worse than nasty, smell in a bath, even where there is of course a constant flushing from the passage of the waste water. You will find that to be the case where the air comes in through a long untrapped waste-pipe, and if that applies to a bath, it certainly applies still more to a sink.

Now, rain-water pipes and gutters are very fertile sources

of disease. Rain-water pipes are not unfrequently placed inside houses—in fact they are very frequently placed inside the house. They start away up at the top of the house, and they pass down through the rooms; they go through the bedrooms on the top floor, then through the best bedrooms—I am speaking now of a particular instance within my own knowledge—through the drawing-room, through the dining-room, and a room in the basement, into the drain. Of course it is supposed they can do no harm; because they are intended for nothing but rain-water. Workmen only consider what goes down pipes, not what comes up them. If there is a trap at the foot of such a pipe, it is very little better; but if not, it is as bad as can be. Foul air comes out through leaky joints, which were never attempted to be made tight, into the rooms, and illness is the result. That is an exceedingly common thing, and rain-water pipes, therefore, ought always to be put outside the house wherever they can be, and they ought certainly not to be connected with the drain; but ought to be constructed to discharge over areas, like sink pipes.

Then, with regard to rain-water gutters. They are frequently made inside houses, in order to avoid the appearance of gutters passing along the outside. When they are placed under the roof, but above the ceilings, it is not a very serious thing; but that is not always the case, and it is not an uncommon thing for rain-water gutters to be carried from the front of the house, right through under the floor of the top story, into a head at the back of the house, to avoid having the appearance of a pipe outside. It is an exceedingly common thing for rain-water gutters to be carried in that way. They are leaden gutters, with very little fall as a rule. Dead leaves, soot, and all sorts of things get collected in them—even dead birds are sometimes found in them—and of course where that is the case, it will produce foul air in a house. I have known plenty of instances of disease occurring from sleeping in rooms where the gutters have been carried along inside under the windows. There is

nothing to show what they are, and they look simply like window seats. If you were to take the nails out, and get the top off, you would very likely find underneath what is called a "box-gutter," and you would also very likely find it in a very filthy condition.

The next thing I will mention, is the connection of the waste-pipes, or overflow-pipes of cisterns with the drains or with the water-closet apparatus. They are exceedingly commonly connected directly with the drains, with the D trap of a water-closet, or, perhaps, even with the soil-pipe. Of course that is exceedingly wrong; foul air comes up and contaminates the water in the cistern. And the foul matters so brought into it may contain the poison of enteric fever or of diphtheria; they frequently do so in London. This is a very important point in sanitary arrangements, and though I have mentioned it so late, the connection of the overflow-pipe of the cistern with the drain or soil-pipe is by far the greatest cause of enteric or typhoid fever in large towns. There is no question about it; all other sources of illness from defective sanitary arrangements in houses are as nothing, compared with the connection of the waste-pipes of the drinking-water cisterns directly with the drains. I feel that I need not insist any more upon the importance of this subject, as the remarks I have already made to you upon it are so thoroughly well received, and perhaps I had better at once say, that the way to cure that mischief is to cut off that connection of the waste-pipe with the drain altogether, and make it discharge into the open air. In one case in a house in the country, where a bad smell had been perceived, a plumber was sent for, and he examined the cistern, the waste-pipe of which he found to be in connection with either the drain or soil-pipe. Instead of disconnecting it, he did a very curious thing, which I will try to describe to you. He put a conical piece of zinc over the top of the waste-pipe, and a pipe passing from that out through the roof. It was apparently all right as long as the cistern was quite full. The result would

be that any foul air coming into the cistern would escape up that ventilating pipe, and out through the roof; but as soon as the level of the water went down far enough, there was this beautiful arrangement standing quite dry.

Another plan, sometimes adopted, is to put a small trap of some kind on the top of the waste-pipe. Here is an instance of it [producing specimen]. You can see in this where a small bell-trap has been. As long as the connection remains, any arrangement of that kind would be no protection at all; even a difference of temperature in the cistern would cause drain-air to escape into it, so that that is an exceedingly absurd precaution, and practically useless. There are one or two other matters which I wish to mention which, as I have already taken up so much of your time, you will be glad to know will only take a few minutes. One is that smells are frequently found to travel about houses by means of the tubes in which the bell-wires pass. That is a thing which is not as much attended to as it should be. I have seen some very curious instances in which rooms are often made practically uninhabitable by nothing else but the way in which foul air comes in through the bell-wire tubes. They go through the house from floor to floor, little places are left in the walls for them, and cranks are required, and various little arrangements are made under the floors. Of course there must be a passage made for the wires right down to the bells in the basement. Sometimes the bells are in a little cupboard or recess, near some pipe connection; they may be hung in a place where there is a very bad smell. Sometimes they are put up in the boot-hole. I have known instances of bad smells going right up into the upper rooms from that cause. The products of the combustion of gas rise up and make their escape through these bell-wire tubes, and it is not at all an uncommon thing for the products of combustion in the lower parts of houses to escape ultimately into drawing- and bed-rooms through the bell-wire tubes.

One other thing I must mention, and that is the foul air that is produced by a slight escape of coal gas. That is

another important matter. As gas-fittings are not always perfectly tight, a very slight escape of coal gas from them into the rooms frequently takes place. Where that is the case it produces a very peculiar smell, which nobody would ever suppose was from coal gas. It would generally be supposed to be from drain-air, and it is a smell which is exceedingly difficult to recognise, unless people know what it is. But it is an important matter, and you should always be on your guard against it. Whenever there is any doubt about where a smell comes from in a room, smell the gas burners and the chandeliers. That is the only way to detect it ; it is no use applying a light to it, because it mixes with the air much too rapidly to cause combustion or explosion. But you can always smell slight escapes of gas, and where there is such an escape, it is a very serious matter ; because coal gas contains one of the most poisonous of substances, carbonic oxide, which affects the corpuscles of the blood, and the presence of a very small amount of that carbonic oxide in the atmosphere of a room is exceedingly deleterious. It is chiefly due to the presence of this substance in coal gas that people have headache, when they live in rooms where there is a slight escape of coal gas.

Foul air from drains not unfrequently passes into the larders in houses through pipes, which are sometimes directly in connection with the street sewer. I know one instance in which there was a bell-trap not connected with the house-drain, but with a separate one going straight into the street sewer. When that trap was examined, it was found to be as dry as this one in my hand is now, and I venture to say that it had been dry for a year. There had been scarlet fever and diphtheria in that house, and I have no doubt that was caused by the foul air getting into the larder from the street sewer, and so of course contaminating the food in the larder. I remember in particular one instance, which I have mentioned several times before, but which, perhaps, I may mention again now, in which there was a bad smell in the larder, and

nobody could suggest how it came there, until it was found that the soil-pipe of a closet upstairs came down inside the wall of the larder. On examining it there, it was found that a nail had been driven into the soil-pipe, and the dish-cloths and larder-cloths were hanging upon it. There are many other instances of a similar kind, which I might give you. I remember one case in which a water-closet opened directly out of the larder; in fact it formed part of the larder when the door was opened. Of course what I have said of larders applies equally to dairies. It is a very common thing to find sanitary defects in dairies, and in that way the milk gets poisoned and produces diseases, which we know now are caused by the poisonous matters which contaminate the milk, in consequence of those defects.

Another thing which is exceedingly dangerous is the disuse of such arrangements as I have mentioned; any sanitary apparatus that is not used is dangerous. I do not care what it is. The traps become dry; the outer air comes in either through dirty pipes or badly made, carelessly placed, or defective apparatus, and you frequently find cases of diseases being caused by foul air coming into houses, simply on account of such pipes and apparatus being disused. I will mention to you one instance of that which occurred in a school, where there was an epidemic of sore-throats. I should tell you that the school-house consisted of two houses, which had been thrown into one large house for the purpose of carrying on the school. Everything had been done that had been advised, and it was supposed that the sanitary arrangements were perfect. But in one of the houses there was a sink, which was never wanted, with a bell-trap and pipe leading down underneath the floor. It had been thought that might be left alone, and that there was no need to do anything with it. The result was that from disuse, foul air came from it, and in fact the current of air that was coming in through the waste pipe of that sink, and through another bell-trap in the floor just under it, would, to use a com-

mon expression, have "turned a windmill," and it had as foul a smell as any drain air possibly could have.

Now, Ladies and Gentlemen, I am afraid I have very imperfectly performed my task, but I have endeavoured to do my best, and I have now finished it. I will only add that here is a specimen you might like to see. I have referred to the fact that rats sometimes eat holes in lead pipes, and this is an instance of a lead waste-pipe, through which a rat has eaten a hole large enough to enable him to get into the pipe.

A vote of thanks was passed to the lecturer.

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